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VARIABLE OPTICAL ATTENUATOR

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The present invention relates to an optical attenuator, and particularly to a variable optical attenuator having an electrical controlling circuit.

2. Description of the related art

[0002] Optical attenuators are used to optimize the optical power of signals at key points in optical communications networks. For example, in networks having Erbium Doped Fiber Amplifiers (EDFAs), optical attenuators are used between stages of EDFAs to provide constant gain. In Wavelength Division Multiplexer (WDM) systems, optical attenuators are used to adjust optical power of "added" laser signals to match the signals strength of other channels within the network. Optical attenuators can also be used to set signal strength within the range of a particular receiver.

[0003] Known methods to obtain a variable optical attenuator include coating a filter element with an attenuation layer having a variable density, and bending optical fibers to get a given attenuation. A variable optical attenuator can also be obtained by changing a distance between a reflector and an input port or an output port.

[0004] U.S. Pat. No. 5,745,634 discloses a voltage controlled attenuator comprising a first lens for receiving an incoming light beam, a second lens for outputting the attenuated light beam, an optical detecting means and a controllable attenuating means. The optical detecting means monitors the intensity of the

attenuated light beam, and the controllable attenuating means varies the attenuation of the outgoing light beam in response to signals from the detecting means. However, making the attenuating means (such as variable neutral density filters or wedge shaped filters) is very difficult. Further more, when a light beam passes through the filters, the reflections of the light beam at the interfaces of the filters can cause the intensity of the outgoing light beam to fluctuate.

BRIEF DESCRIPTION OF THE INVENTION

[0005] An object of the present invention is to provide an optical attenuator which controllably attenuates a light beam by using an electrical controlling circuit.

[0006] Another object of the present invention is to provide an optical attenuator having a simple structure.

[0007] An optical attenuator in accordance with the present invention comprises: an input port, an output port, a fixed reflector, a movable reflector, two detecting means and a driving device. The input port includes a first collimator and a filter attached to the collimator. The output port includes a second collimator and a splitter connected to the collimator. Input signals are transmitted from an input fiber through the first collimator and then pass through the filter. The signals passing through the filter are directed by the fixed and the movable reflectors to the second collimator. The rotation of the movable reflector will lead to a different coupling between the reflected signals and the second collimator. The detecting means detects the intensity of input signals and output signals and then calculates the attenuation ratio. The driving device then drives the movable reflector in

response to the attenuation ratio coming from the detecting means.

BRIEF DESCRIPTION OF THE DRAWING

[0008] FIG. 1 is a schematic diagram of a variable optical attenuator according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0009] As shown in FIG. 1, an optical attenuator 8 of the present invention comprises: an input port 1, an output port 4, a fixed reflector 2, a movable reflector 3, two photodiodes 6, 7 and a driving device 5. The optical attenuator 8 attenuates optical signals traveling along an optical path.

[0010] The input port 1 includes a first collimator 13 and a filter 10 attached to the first collimator 13. One end of each of an input fiber 11 and an input sampling fiber 12 are retained in the first collimator 13. The output port 4 includes a second collimator 41 and a splitter 42 connected to the second collimator 41. One end of each of an output fiber 421 and an output sampling fiber 422 are retained in the splitter 42.

[0011] Input signals are transmitted along the optical path (not shown) through the input fiber 11 and into the first collimator 13, and then pass through the filter 10 to the fixed reflector 2. The filter 10 reflects a small part of the input signals, and these reflected signals are directed back through the first collimator 13 to the input sampling fiber 12, and then to the photodiode 6. In this embodiment, the filter 10 reflects about 0.5 percent of the signals input to it. The fixed reflector 2 and the movable reflector 3 are arranged at such an angle that they ensure that

some portion of the signals reflected by them are received by the second collimator 41. The signals passing through the second collimator 41 are split by the splitter 42 to be directed along the optical path (not shown) through the output fiber 421 as output signals or to be directed to a photodiode 7 via the output sampling fiber 422. With the apparatus of the present invention, 98 percent of the signals from the second collimator 41 can be transmitted to the output fiber 421.

[0012] The photodiodes 6 and 7 detect the intensity of signals transmitted through the input sampling fiber 12 and the output sampling fiber 422, respectively, and these intensities are used by control circuitry to calculate the intensity of the input signals and the output signals. The control circuitry also calculates an attenuation ratio from the signals received by the photodiodes 6 and 7, and uses this attenuation ratio to drive the driving device 5. The attenuation ratio is the ratio of the output signals to the input signals. The driving device 5 then drives the movable reflector 3 to turn to an appropriate angle to achieve a desired attenuation ratio. As the movable reflector 3 rotates, signals reflected off the movable reflector 3 couple in different proportions with the second collimator 41, which changes the attenuation ratio. In other words, as the movable reflector 3 rotates, a portion of the signals reflected off the movable reflector 3 can couple with (pass through) the second collimator 41, and a portion can miss the second collimator 41.

[0013] It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles

of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.